Modern Methods in the Treatment of Fractures

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The treatment of fractures is of perennial interest. The complaint is common to any age. It may occour at any time of life. A fracture may usher in the new-born babe. It may ring down the curtain at the other end of life. The frequency of the complaint is not diminishing. With the increase in speed it is actually increasing.

It is only by using a high standard of comparison that a high standard of treatment can be obtained. In fractures that standard is the reproduction of the normal. To obtain it, Lister violated the canons of surgery. He converted a simple fracture into a compound one when he wired a fractured patella. But the genius of Lister did not popularize the method. It took the technical skill and personality of Lane to show that the opening up of a simple fracture, and fixing of the fragments in accurate anatomical apposition, was a justifiable and even desirable method.

The advent of X-rays was the cause of the next advance in the treatment of fractures. It was no longer necessary to cut down on the seat of fracture to see the position of the bony fragments. It was found that manipulation in itself, if assisted by X-ray examinations, could produce good anatomical apposition in certain fractures. X-ray examinations were especially helpful to those who followed the teaching of Hugh Owen Thomas: they could now watch the progress of their fractures, and their treatment became more of an exact science. In this way treatment in the Thomas splint became more popular.

The exigencies of war finally set the treatment of fractures on its present basis. It showed the weak points in the methods of open operation. The septic nature of the wounds drove surgeons to dispense with Lane's fixation methods by foreign bodies and to use traction as a means of holding the fragments in apposition.

It was found that the results obtained by traction were better than those obtained by operative fixation, and the mortality was greatly lowered. This, coupled with an efficient method of keeping the fragments from moving during transport, lowered the total mortality for fractured femora from eighty to sixteen per cent. The method adopted in our lines was the universal use of the Thomas ring-splint. Our enemies learnt the same lesson, and they had a like drop in their mortality; the splint adopted and modified by them was the Braun splint. The Thomas splint has the advantage over the Braun splint in that it is more easily adopted for transport and it allows of more movement of the limb without allowing movement of the fragments. The war signed the death warrant of plates and screws. It exalted the ring-splint of Hugh Owen Thomas. It established the principle of skeletal traction.

When a force is applied to a bone, it is fractured in the direction of the line of force. A twisting force will produce a spiral fracture, and a direct blow a transverse fracture.

The position the fragments will take depends to the greatest extent upon the disrupting force. But it is influenced by the attachments of muscles and ligaments. Where muscles are attached closely to a bone, the muscular fibres may hold the fragments in apposition, as, for example, in a fracture at the angle of the jaw. No displacement may likewise be shown by a fracture between ligaments, as in a fracture of the clavicle between the conoid and trapezoid ligaments. In a fractured patella due to a direct blow, the muscular fibres still hold and there is little displacement : but in that due to a sudden contraction of the quadriceps with the knee bent, the patella is broken by leverage over the prominence of the femoral condyles (fig. 10), and the muscular violence, still acting, tears through the facial and muscular fibres on each side, and the fragments are widely separated.

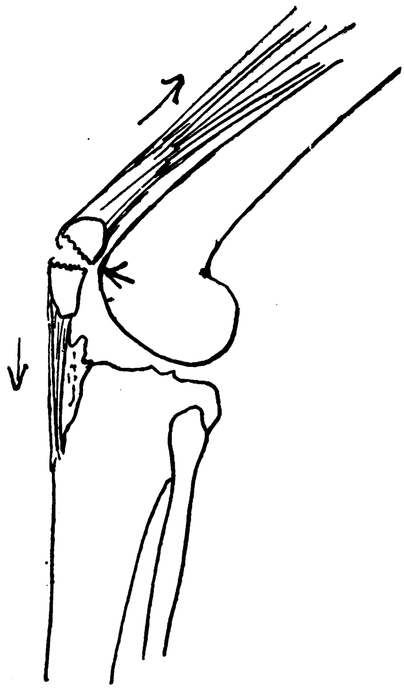

FIG. 10

To illustrate how the patella is fractured by being levered over the lower end of the femur in fracture by muscular violence.

A Colles fracture through the lower end of the radius illustrates well the parts played by the several factors—force, muscles, and ligaments. The fracture takes place with the hand outstretched (fig. 1). The line of force is upwards and backwards. This determines the line of fracture. The force pushes the lower fragment upwards and backwards, and in so doing the lower articular surface is rotated slightly backwards. By the attachment of the lower fragment to the ulna through the triangular ligament, its upward movement is restrained and it is made to swing in an arc towards the ulna (fig. 2). Sometimes the strain on this ligament is too great, and the ligament breaks off the ulna styloid. In these cases there is more upwards displacement, unless impeded by the impaction of the fragments. In more violent disruption the impaction comminutes the lower frag-

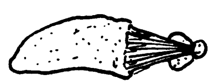

FIG. 2

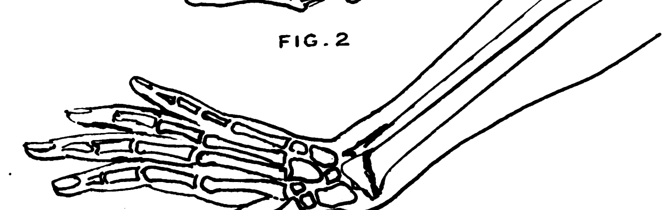

FIG. 1

The line of force in the case of a Colles fracture of the radius. The lower fragment will be driven upwards and backwards.

FIG. 2.

The lower end of the radius and ulna, showing the triangular ligament binding the lower end of the radius to the ulna.

ment. The hand follows the lower radial fragment, and so the typical deformity is produced.

There is a delicate reflex mechanism between the muscles playing and the bones and joints over which they play. This reflex prevents dislocations and fractures in strong muscular efforts. Unused muscles are quickly followed by atrophied bones. One can then understand the sudden violent, powerful muscular contraction when a bone is broken. It is this spasm which exaggerates the deformity and maintains shortening. It is on this physiological fact that the treatment by skeletal traction depends.

The principles of skeletal traction are exemplified by the treatment of a fracture of the shaft of the femur. Here the over-riding of the fragments and the deformity are maintained by the contracted muscles. If a pull is applied to the fractured limb, the muscles are stretched, tired out, and relax, thus allowing the pull to correct the over-riding of the bone-ends. The normal bones lie with a balanced thrust of muscles around them, even shaping the bone itself : it follows that in a case of fracture the muscles will lie only in their normal line and relationship when the bone-ends are again lying in their normal relationship. In stretched condition of the muscles they will tend to press the bone-ends into normal position. If all the muscles acting on the femur arose from the pelvis at equidistant points from the line of the femur, and were inserted into the head of the tibia, the correction of deformity in the case of a fractured femur would be easily and perfectly accomplished by a pull on the tibia in the line of the femur. Unfortunately for the surgeon, some muscles arising from the pelvis are inserted at different angles and at different points along the shaft of the bone, and some into the head of the tibia. Also, some muscles pass only from the femur to the tibia. The ilio-psoas, pectineus, and small rotators are inserted high up, the gluteal muscles a little lower, and the adductors lower still. The psoas passes to the front, the gluteal obliquely downwards to the outer side, and the adductors obliquely down to the inner side. The popliteus, short head of biceps and gastrocnemii, pass from the back of the femur to the tibia. Besides these factors, the femur is an angled bone. It follows then that a fracture in the shaft will change the axis of movement. For example, the psoas is normally an internal rotator. If the femur is fractured through the neck, the psoas will, due to this change of axis, become an external rotator; hence one cause of the marked eversion of the foot in a case of fracture through the neck of the femur. If traction is to be employed intelligently, these factors must be recognized and the site of

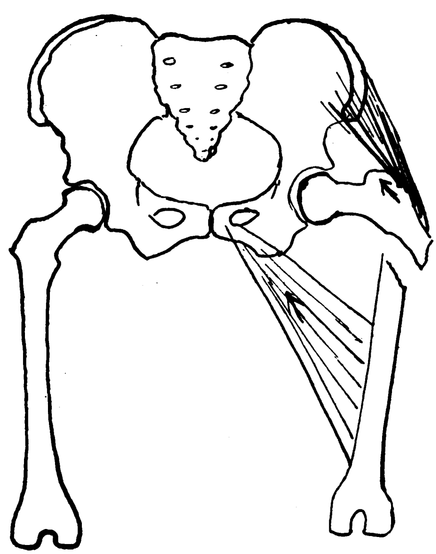

FIG. 3

A fracture through the upper third of the femur, showing how the upper end of the femur is abducted by the gluteal muscles.

the fracture taken into consideration.

In a fracture of the upper third of the shaft of the femur, the gluteal muscles have the greatest power on the upper fragment. Its abduction action is practically unopposed (fig. 3). The upper fragment is abducted markedly by the gluteal muscles and pulled forward by the psoas and pectineus muscles. This abduction can only be neutralized by putting the lower fragment in a like flexed and abducted position. Thus traction is applied to the lower fragment, with the limb in flexion and abduction. In fracture of the middle third, more of the adductor action is applied to the upper fragment, hence this fragment is not so abducted, and the limb should be treated with only slight adduction depending on the actual level of the fracture. In a fracture of the lower end, the whole adductor group is brought to play on the upper fragments, and it becomes adducted (fig. 4), the lower fragment is tilted back by the short head of the biceps and the gastrocnemii (fig. 5). This fracture can be treated in adduction, or a lateral pull is applied to the lower end of the upper fragment to neutralize this adducting

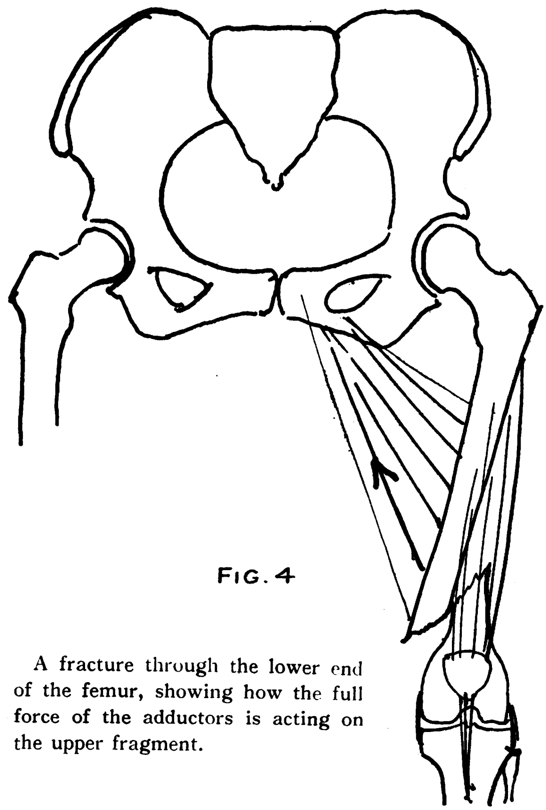

FIG. 4

A fracture through the lower end of the femur, showing how the full force of the adductors is acting on the upper fragment.

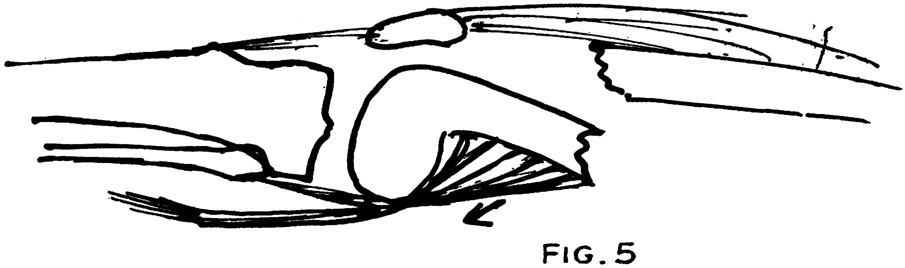

FIG. 5

This diagram illustrates how, in a fracture of the lower end of the femur, the lower fragment is drawn backwards by the short head of the biceps and the gastrocnemii.

force. The tilting back of the lower fragment is neutralized by a pull forwards, or more simply by a thrust from the back, obtained by bending the splint forwards at this point. The law of pulling in the direction in which the proximal fragment points is a good guide, though it may on occasion need amendment.

As most of the muscles causing shortening are attached to the tibia, it follows that the traction force is best applied at this point. It may be applied through the extending force being stuck to the skin or fastened to pins passed through the crest of the tibia.

Traction may be applied by weights over pulleys, or by using the ischial tuberosity as a counter-pressure point and tying the strings pulling on the limb over the end of a Thomas ring-splint. The latter method needs constant attention, and the skin is likely to develop a pressure sore. Weight and pulley is the better method. The weight may be applied to the limb through being glued to the skin or being tied to a pin passed through bone. As the majority of the muscles causing the shortening are attached to the tibia, the pin is best passed through the crest of the tibia. Pins have many advantages over glue, in that the patient is more comfortable. There is no drag to cause pain, no skin sores, and no necessity of changing the sticking plaster or glue, and, finally, there is no limit to the weight that can be applied. The pins may be as thick as a quill, or may be as fine as a darning needle, as in Kirschner's wire.

In pulling out a fractured femur in a strong muscular adult, a weight of thirty pounds may be necessary, and it should be applied right from the first day of treatment. Later on it is more difficult to undo the shortening. When a quarter-inch lengthening is obtained, some of the weight may be reduced. If the knee is kept slightly bent the ligaments are not strained. Any fractured femur can be pulled out to its normal length.

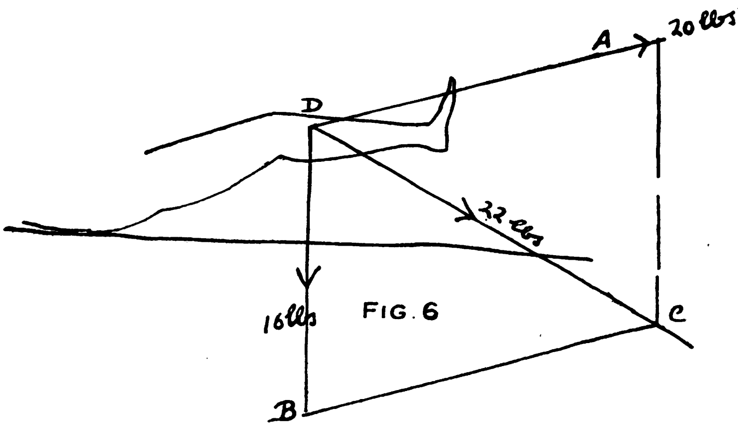

FIG. 6

In a man of eleven stone weight, the weight of the limb acting down at the point D is about sixteen pounds. If even a weight of twenty pounds is applied in the line of the limb A, to pull out the fracture, without the weight of the limb being supported, the resultant of the force applied is in the direction D—C, and its amount is twenty-two pounds. There will be no hope of the shortening being overcome.

In applying this traction, one must not lose sight of the parallelogram of forces (fig. 6). When a limb is suspended on a Thomas splint, there is the weight of the limb acting down, and it must be neutralized if the pull in the axis of the limb is to be the resultant force (fig. 6). The patient's body is used as a counter-weight to the pull, so the greater the pull the more must the bottom of the bed be raised.

In the after-treatment of all fractures it is to be remembered that callus is strongest at the end of three weeks, and then begins to be absorbd as new bone is laid down. In this process the union becomes weaker, so that six weeks have elapsed before there has been sufficient bone laid down to equal the strength of the callus that has been absorbed. Union is weaker at four weeks than at three weeks, and at six weeks union is only equal in strength to union at three weeks.

In the case of the fractured femur, the limb must be maintained at its proper length for at least six weeks. When union appears firm, the splints can be adjusted and the pin removed. A smaller extension-weight to keep the fragments at rest is now applied with sticking plaster or Elastoplast above the knee-joint, and a flexing-iron applied to the Thomas splint (fig. 7). With this the patient exercises his limb

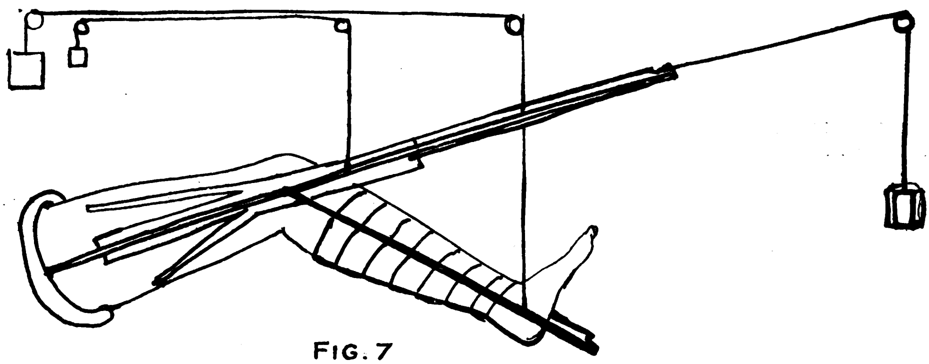

FIG. 7

Diagram to illustrate how the extension is applied to the femur when a flexing-iron is applied.

muscles, and this helps function and hastens union. With a flexing-iron the splint must be kept well applied, so that the joint of the flexing-iron is kept opposite the most prominent part of the femoral condyles. The patient's leg is bandaged to the flexing-iron, and the weight of the leg and flexing-iron is counterbalanced by weights over a pulley. In this way the patient can, more easily, actively extend the knee against gravity. About the end of three months a walking calliper is fitted and the patient allowed up.

This walking calliper must be so made that the ring impinges on the ischial tuberosity when the weight is borne upon it. It should be of such a length that when pressed firmly against the tuberosity its lower end projects at least three-quarters of an inch below the bare heel. In thick-soled shoes it should project one inch below the bare heel. Scarcely five per cent. of walking callipers are correct when delivered by the instrument makers.

The length of time a walking calliper is worn depends to a great extent upon the position of the ends of the fragments. A transverse fracture in good position will need less support than an oblique fracture or a fracture in which there is not accurate end apposition. If the length is maintained and the alignment is good, in time a perfect bone will be formed by the projecting corners being absorbed and the scaffolding bone being laid down at the recesses. If the calliper does not take the weight, or is discarded too soon, the soft bone will bend and the deformity become marked. A child or a lightweight adult does not need to be supported proportionately as long as a heavyweight; for the strain on the lower limbs is not in direct proportion to the weight of the body, but rather in geometric proportion.

The principle of traction is also applied to fractures of the humerus, forearm, or leg bones.

In T-shaped fractures of the lower end of the femur, the knee-joint is involved. Extension is applied, and after thirty-six hours the blood should be aspirated from the joint to ease the pain. If with extension the fragments cannot be held in apposition, it will be necessary to screw them together at open operation. The same procedure applies to fracture of the tuberosities of the tibia. The joint surfaces must be kept accurately apposed.

In fracture of the spine of the tibia, aspiration of the knee-joint may be necessary. The joint is then forced into full extension. This presses down the avulsed spine. After two months, flexing movements begin. Any tendency to limitation of extension is the sign for further rest in the extended position. With care full function can be obtained.

Fractures of the shaft of the tibia are usually associated with a fracture of the fibula higher up, and should be treated with the knee-joint bent to relax the gastrocnemii. The calf should be only loosely supported to prevent the bulky calf muscles pressing the ends of the fragments forwards. Extension is applied through a pin transfixing the os calcis. When the deformity is reduced, the foot, pin, leg, and lower end of the thigh are enclosed in plaster of paris. This plaster of paris is split when wet, so as to allow for any subsequent swelling of the leg. In cases much contused, it is best to keep them in a Thomas ring-splint, with extension for three or four weeks before applying the plaster. At the end of six weeks the fracture should be supported and the ankle- and foot-joints pushed gently to their full movement. After eight weeks the patient should be fitted with a walking calliper or a walking plaster-splint. If, when first seen, there is difficulty in getting good anatomical position, and no grating of bone-ends can be elicited, it is better to do an open operation and place the fragments in position. In many cases fixation plates and wires are unnecessary, and the limb is encased in plaster of paris.

In a compound fracture of the tibia, good results have been obtained from the following procedure. Under low spinal, local, or general anæsthesia, the wound is sterilized by excising the edges of the wound and all injured tissues. A steel pin is passed through the tibia well above the injured part, and another pin through the tibia well below the seat of injury. An assistant pulls on the lower pin and turns it till the fragments lie in accurate apposition. If the wound is large, it is loosely sutured together and a small area left open. This is packed with vaseline, and sterile dressings applied. The whole limb from the knee down is then encased in plaster of paris. The pins embedded in the plaster effectively prevent any chance of movement between the fragments. The plaster may be left on from six to eight weeks, the pins can then be dispensed with, and the fracture treated as the usual healing fracture.

This principle of transfixion pins and plaster of paris, slightly modified, has been of use in treating a patient with a compound comminuted fracture of the femur and a compound fracture of the tibia and fibula in the same limb. A pin is first passed through the crest of the tibia, the wounds sterilized by excision, the leg bones put in accurate apposition by holding the pin and pulling and rotating the foot. The wounds are then dressed with vaseline and sterile dressings. The leg from the knee down and the foot are then encased in plaster of paris. A Thomas ring-splint is applied, and the projecting ends of the pins used for applying extension through weight and pulley to the femur. In this way a limb with no shortening and good anatomical union has been obtained (see plates A, B, and C).

In fractures around the ankle-joint, full reduction must be obtained. If the fibula is broken, the lower fragment must be firmly pressed towards the tibia, so as to force the astragalus across (fig. 11). With marked displacement, the foot is displaced back and the posterior edge of the tibia is frequently broken off. The patient should be placed with the knee bent and the leg hanging over the end of the table, and a bandage passed loosely from above the ankle round the leg of the table. The operator grasps the heel with his two hands and pulls it forwards and upwards to produce full dorsi-flexion of the ankle-joint. The foot should be maintained in plaster of paris. In the after-treatment of these cases the tarsal joints should be gently moved through their full range from the fourth week, but splintage should be maintained for at least three months. In cases where the fibula has been broken, the patient should wear the inner side of the heel and sole of the boot raised for the ensuing twelve months.

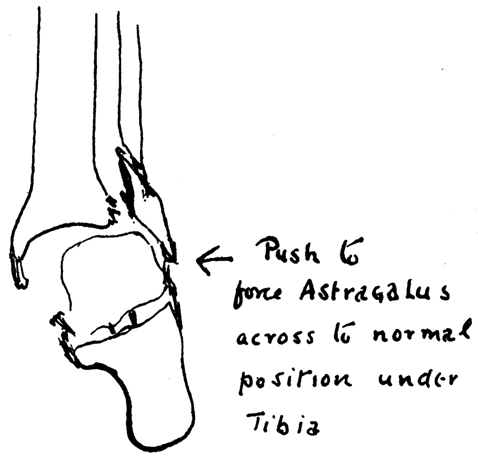

FIG. 11

An abduction fracture of the lower end of the fibula, with tearing of the intra-lateral ligament. The astragalus is displaced laterally with the fibular fragment. In reducing the fracture, the lower end of the fibula with the astragalus must be pushed hard up against the internal malleolus.

Fractures of the os calcis as a rule produce some permanent disability. The fracture often extends up into the subastralagoid joint, and osteo-arthritis of this joint follows. Early treatment consists in reproducing the arch and reducing the broadening caused by a longitudinal splint. A pin is passed through the os calcis and traction applied to reproduce the arch, and it may be necessary to tenotomize the tendo achilles. When the foot is remoulded it is encased in plaster of paris. In cases where there is pain following a fracture into the subastragaloid joint, an arthrodesis of this joint is indicated to relieve the pain.

An infant may have its humerus fractured during delivery. Here the fracture is usually low down in the surgical neck, or in the middle of the shaft. It is best treated with the arm in an abducted position. An abduction splint may be easily constructed by bending a piece of metal in an Z shape. One limb of the Z is sewn into the binder, and the flexed arm is bandaged to the other limbs of the Z. Separation of the upper epiphysis of the humerus occurs between ten and fifteen years. It is best reduced by Bohler's method. The child lies down on the floor anæsthetized. The surgeon, sitting on a chair beyond the patient's head, places his stockinged foot on the anterior-external surface of the shoulder; he catches the wrist of the affected arm and pulls upwards and outwards, using the heel to lever the upper end of the diaphysis into position. The arm is best placed in an aeroplane splint. Once properly reduced there is little tendency to displacement.

Fractures through the tuberosities of the humerus are nearly all in old people, and got by direct violence to the shoulder. An aeroplane splint is, as a rule, all that is required.

If the head is dislocated as well as fractured through the surgical neck, the arm is forcibly pulled by an assistant in an abducted direction, the stockinged foot being placed in the axilla as a counter-pressure if necessary. The surgeon then presses the dislocated head back into the glenoid fossa. Treatment is then that of a fracture of the surgical neck.

In a fracture of the surgical neck, extension is applied either in the abduction or in the line of the body. In the abducted position a Bohler's splint may be used and the patient can walk about, or a Thomas ring-splint may be used, keeping the patient in bed until union is firm (about six to eight weeks). Movement is then encouraged.

Traction in the line of the body has been lately advocated in fractures of the surgical neck of the humerus. It is first ascertained if the long head of the biceps is still intact. If the head is intact, the patient will complain of pain at the site of fracture on extending the elbow. If the

FIG. 12

Howard and Eloesser's method of reducing a fracture through the surgical neck of the humerus.

tendon is ruptured, open operation is indicated; if the tendon is intact, the site of fracture is infiltrated with two per cent. novocaine, with a few drops of adrenalin added; a sling is placed around the forearm of the affected arm, the surgeon places his foot through the other loop, the patient being seated in a chair. An assistant stands behind the patient, and with his contra arm reaches over the shoulder on the sound side and grasps the wrist of the affected side. With his other hand he steadies the upper fragment. The surgeon then standing at the side of the patient, presses down forcibly with his foot in the sling, and with his hands manipulates the fragments into position (fig. 12). The after-treatment is simple. A pad is placed in the axilla, and some wool around the arm. A short sling keeps the elbow flexed, and the arm is bound loosely to the body.

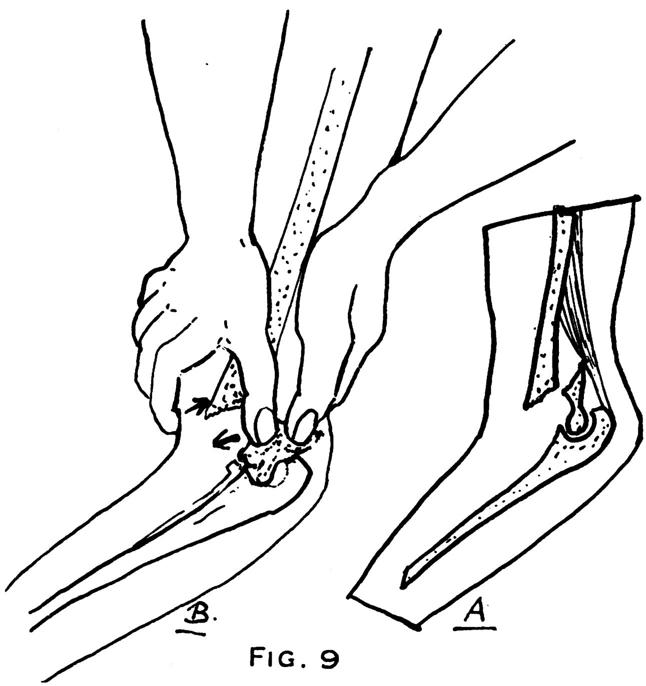

FIG. 9

A—The displacement in a supracondylar fracture of the humerus.

B—A method of reducing the displacement.

The supracondylar fracture is one of the most difficult fractures in the body to treat if not accurately reduced within twelve hours from the accident. Once marked swelling has taken place, the difficulties of reduction are enormously increased. The lower epiphysis is displaced backwards, taking with it a small piece of the diaphysis. For reduction, traction is made on the forearm; the method of using a sling, as related above in the case of a fracture of the surgical neck, is useful. The surgeon stands to the side of the patient and grasps the lower end of the humerus with both hands. His fingers being locked in front over the end of the proximal fragment, he uses both his thumbs to lever the lower fragment downwards and forwards (fig. 9). The restoration of a convex curve at the back of the elbow-joint, and ease in placing the elbow in full flexion, are indications that the fracture has been fully reduced. An immediate X-ray picture is necessary to make sure that not only the backward displacement has been fully reduced, but that any lateral displacement has been corrected. The pulse is examined to see that the circulation is not interfered with, and the parents are warned to report if any swelling or discoloration of the hands or fingers occurs. If, after reducing the fracture, the circulation seems unsatisfactory, the hand should be tried in a fully pronated position; if this is not satisfactory, the surgeon should again make certain that reduction is complete. If, when first seen, there is much swelling around the elbow, and the pulse at the wrist-joint cannot be felt, an attempt should be made at reduction. On reduction of the fracture, the pulse will probably improve. If, in spite of reduction, the circulation is still poor, the case should be treated as an emergency, and the skin and deep fascia should be incised to lower tension, when the pulse at the wrist-joint will improve. In this way a Volkman's ischæmic contracture, a most crippling condition, will be avoided.

Fractures of either epicondyle of the humerus should, if there is any displacement, be reduced by open operation, and the fragments sutured in position or fixed by a nail.

In fractures around the elbow-joint, the ulnar, median or musculo-spiral nerve may be interfered with. The ulnar-nerve lesion may be due to severance, contusion, caught in callus, or may only occur thirty to forty years after the accident. These late paralyses occur when the outer condyle has been fractured and not united, or has united, causing an increased carrying angle at the elbow-joint. In time the overstretched nerve suffers a physiological paralysis. If a paralysis occurring at the time of accident shows no improvement four weeks after the reduction of the fracture, it should be exposed by operation. Cases of late ulnar-nerve paralysis should be treated by transposing the nerve to the front of the joint.

In fractures of both bones of the forearm, it must be noted that a fracture of the shaft of the ulna is frequently associated with a dislocation of the upper end of the radius, and fracture at the shaft of the radius is frequently accompanied by a fracture at the lower end of the ulna.

These fractures of both bones of the forearm are reduced by traction in the line of the forearm in a Thomas arm-splint or in a Bohler splint. The traction should be continued for six weeks, when union should allow of placing the limb, with the elbow flexed to beyond the right angle, from the middle of the arm to the knuckles of the hand in plaster of paris. Where traction does not quickly show signs of reduction, it is best to cut down on the most displaced bone, and place the fragments in end-to-end apposition. No screw or plate is, as a rule, required. This gives a fixed fulcrum on which to manipulate the other bone and secure good apposition. The whole limb is then enclosed as before in plaster of paris.

A Colles fracture is best reduced by Jones's method. The operator should stand well over the patient, so that he can get his shoulder muscles into the twist and downward push. In this method for a fractured right radius, the surgeon places his right scaphoid over the lower end of the proximal fragment, and his left scaphoid over the upper end of the distal fragment, and as he forces the lower fragment downwards and forwards, he pushes the upper fragment upwards and backwards. He can gain extra power if he places his foot on a chair and uses the inside of his knee to increase the power of his wrists. As a final thrust, he should push the lower fragment towards the ulna. Plaster of paris is then applied, with the hand midway between pronation and supination, and midway between extension and flexion. This plaster runs from below the elbow to the knuckles. The thumb and fingers are allowed full play. The plaster is split in two places while still wet. The patient is encouraged to use the fingers from the first. After fourteen days one-half of the plaster is removed for light massage and replaced. The wrist should not be used without a plaster of paris support for eight weeks. When supported it may be gently moved once daily through each movement. Special attention should be paid to active movement of the long extensor of the thumb. It is likely to become adherent to the seat of fracture and to rupture later.

Fractures of the scaphoid should be put up in plaster of paris in extension and slight ulnar adduction. This casing should fit accurately, and should be worn for two months, or until the union is sound. Full use of the hand is encouraged when wearing this splint.

Operation is necessary in a fracture of the olecranon and fracture of the patella with separation. Operation should also be done early in cases of intra-capsular fractures of the neck of the femur. In the latter cases a low spinal anæsthesia is given, and the fracture reduced by pulling on the limb, first slightly flexed and adducted, then internally rotated, and then slowly abducted in the internally rotated position and the knee extended. Reduction is probably accomplished if, on resting the heel of the affected limb on the surgeon's palm, the foot does not rotate back into the marked external rotation, but lies in a normal way. Other proofs are the restoration of normal length and the restoration of the hollow behind the great trochanter. Final evidence is the X-ray appearance, plates being taken in two planes. If the fracture is accurately reduced, an incision is made down to the trochanter, three or four Kirschner wires are drilled into the neck to meet the centre of the head, X-rays are again taken, and the wire that lies in the most central position and which is correctly placed, is chosen, and the other pins withdrawn. A Johansen's modification of Smith-Petersen's pin is threaded along this wire as a guide, and driven up through the neck into the head. The patient is returned to bed without any fixation apparatus. The following day the patient can raise the limb from the bed, and can be allowed up in about four weeks (see plates A, F, G, H, and I). In this treatment the operative interference is very slight, and the patient avoids the pain of any movement of the body, chest complications, and the difficulty of nursing; as well as being guaranteed a useful limb.

Most fractures of the spine are due to excessive bending, and it is sound treatment to carry them face downwards, unless one has reason to suspect that the ribs are also crushed. Operation is only to be recommended if there is increasing paralysis, or if, after some improvement, the paralysis remains stationary. In most cases manipulation and plaster are all that is necessary. In some resistant cases an infiltration of the injured area and more forcible manipulation are necessary. The patient is laid face downwards, his head and arms resting on one table and his legs on another table. The spine is thus sagging in hyper-extension; if necessary, some pressure may be applied to increase the hyper-extension. This reduces the deformity.

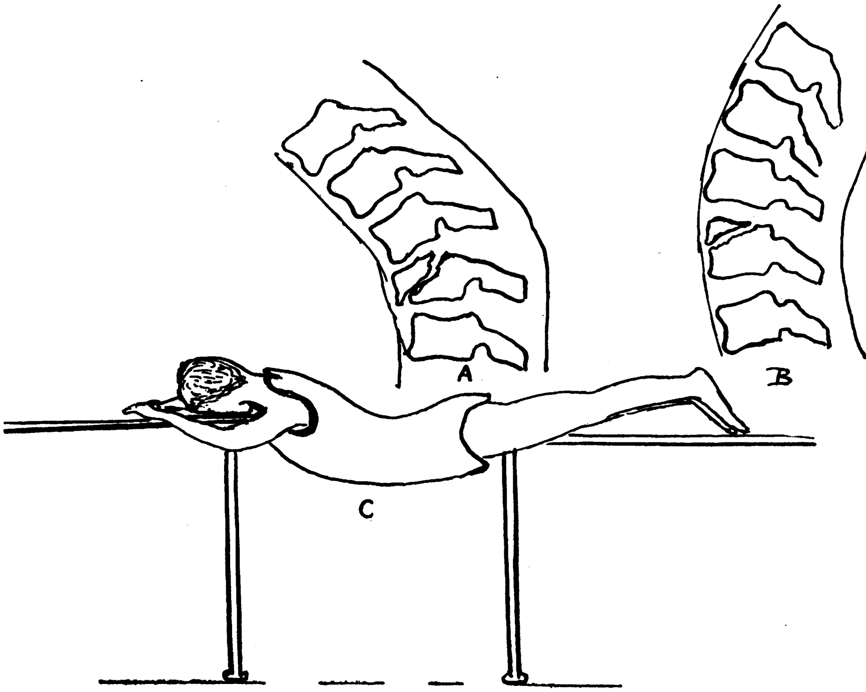

FIG. 8

A—The displacement that is common in a fracture of the spine.
B—When the spine is hyper-extended the displacement is corrected.
C—The plaster jacket applied in the hyper-extended position.

Pads of felt are stuck on the prominent bones, and the patient is then encased in plaster of paris in this hyper-extended position, from the nape of the neck to the buttocks. A large window is cut out in the front to allow of abdominal movement. This casing is worn till the X-ray shows sound bony union (fig. 8). The patient can be allowed up in his jacket after three weeks if he is otherwise fit.

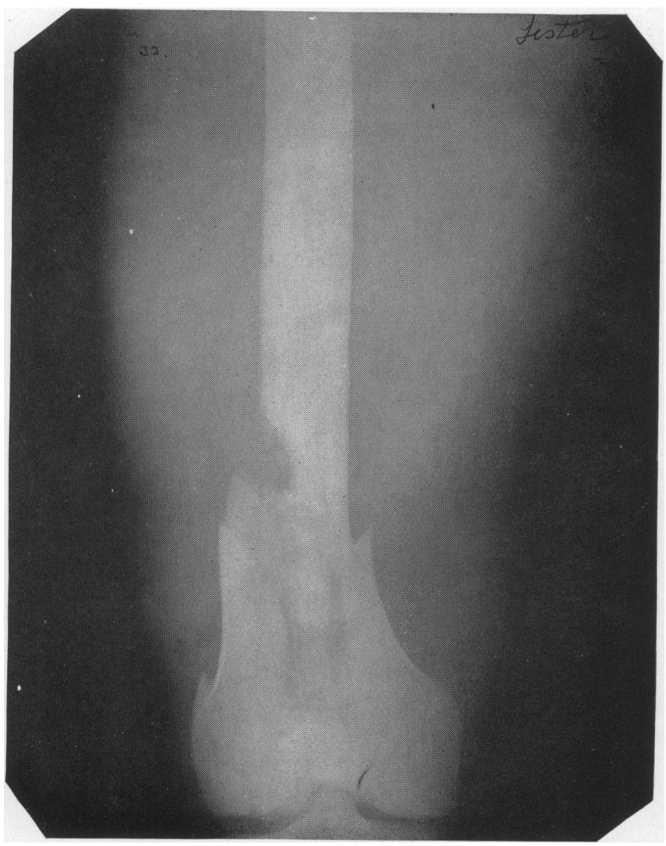

PLATE A.

Comminuted compound fracture of the femur, with involvement of the knee-joint. A piece of the lateral side of the bone five inches long had extruded itself through the wound and was loose in the patient's trousers. There was two inches shortening. This patient had a compound comminuted fracture of the tibia and fibula on the same side.

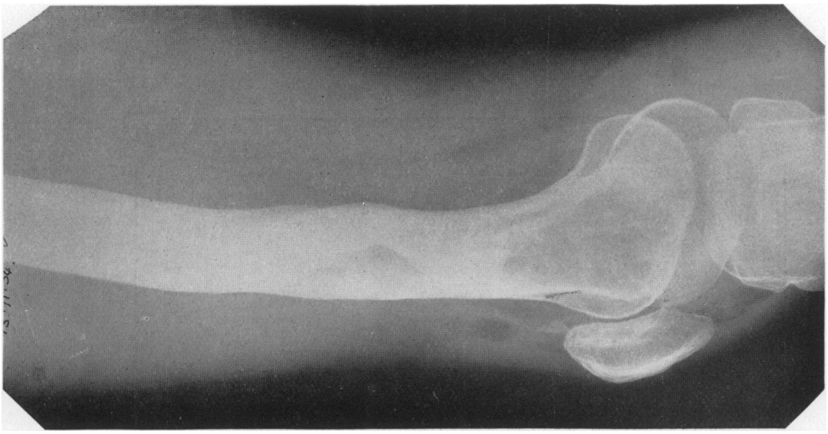

Plate C.

The final result. There is no shortening in the limb and the patient can flex the knee to eighty degrees.

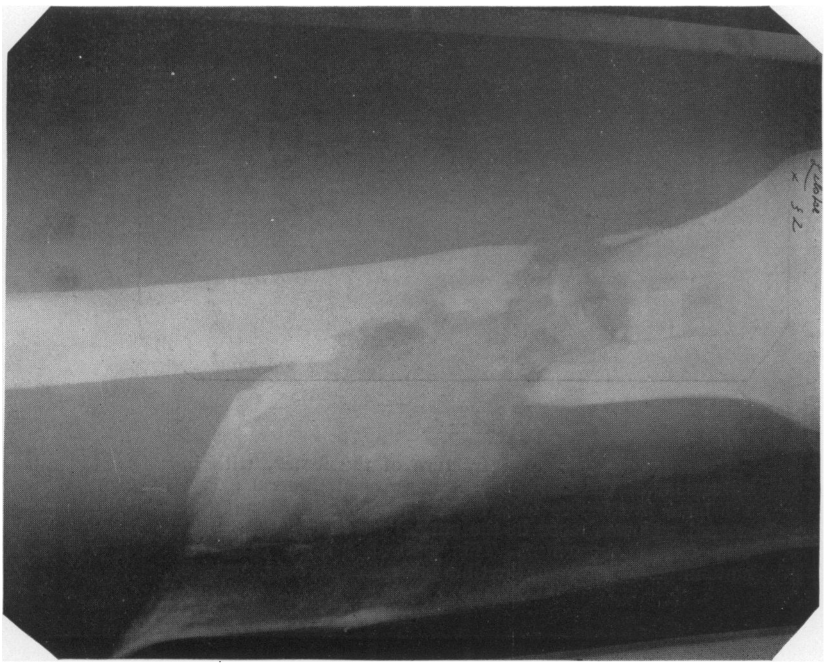

Plate B.

The shortening of the femur has been overcome by traction and the length maintained in traction.

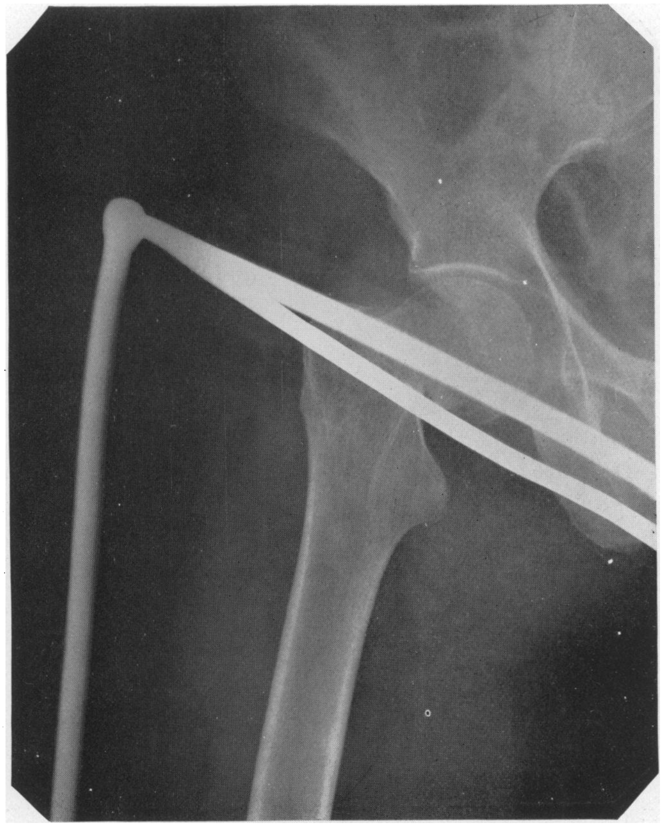

PLATE F.

A typical intracapsular fracture of the femur.

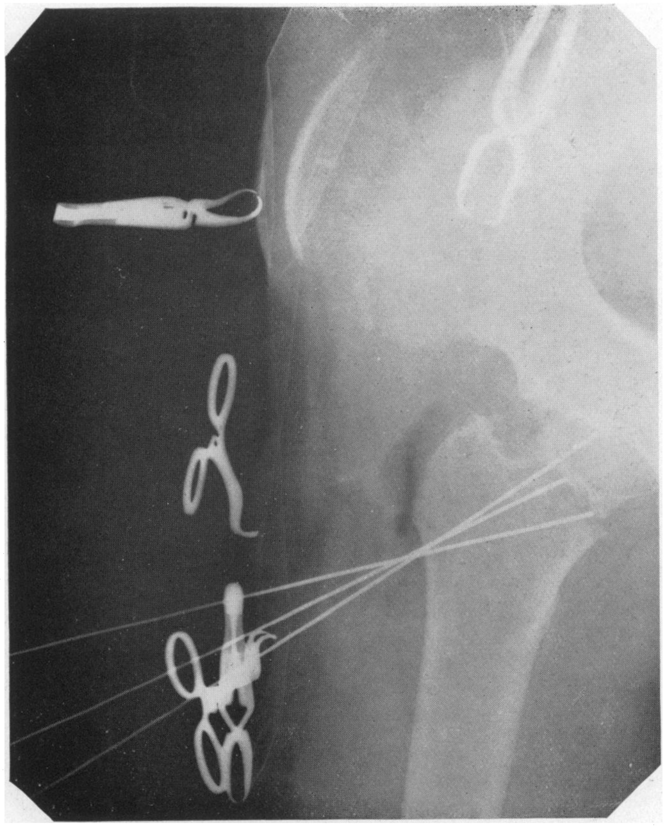

Plate G.

The displacement has been corrected by manipulation and three Kirschner wires inserted as guides.

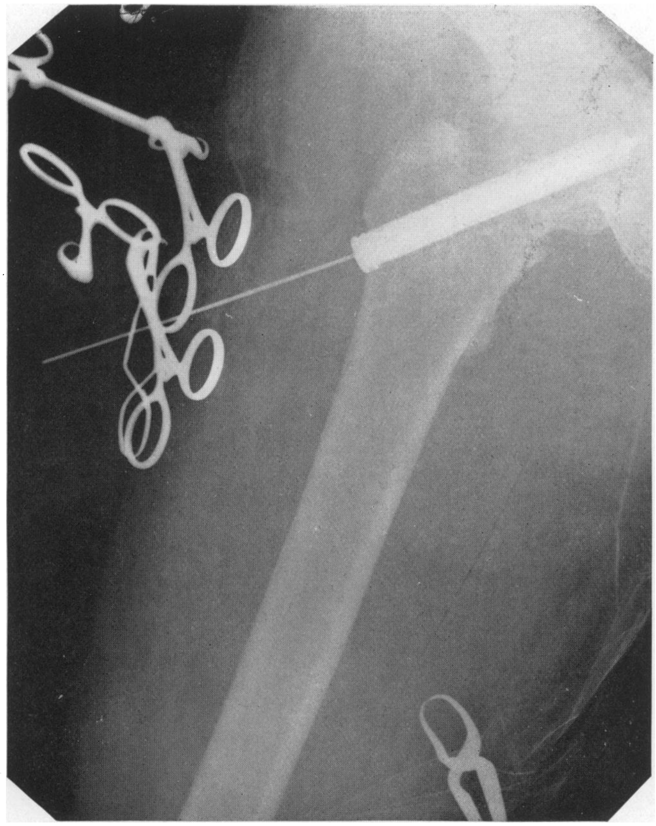

PLATE H.

The most suitably placed wire is chosen and the others withdrawn, and a Johansson's modified Smith-Petersen's nail is threaded on this wire as a guide and driven into the bone, uniting the fragments.

PLATE I.

The final result. The patient is walking about without pain, and the fragments appear firmly united.